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Impact of the utilization of a product configuration system on product's life cycle complexity

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Abstract

The purpose of this paper is to identify areas throughout a product's lifecycle processes where complexity can be reduced by implementing a product configuration system (PCS). As discussed in the literature, several benefits are realized by using a PCS in terms of product and process standardization. This also leads to control and reduce of complexity both in products and processes. To this end, this research attempts to quantify and assess these benefits and is supported by empirical evidence. A case study of an engineering company is used and the results indicate significant improvements for the company in several life cycle processes.

Keywords: Complexity, Product Configuration System (PCS), Product life cycle

Purpose

This paper aims to pursue the research opportunity of exploring the overall impact on complexity reduction throughout the products' life cycle by implementing a product configuration system (PCS) in the early sales phase (Figure 1). The literature describes various benefits that can be gained from implementing PCSs, however the connection between those benefits and the effects on complexity reduction in the different phases of the products' life cycles has not been explored to full extent. This research focuses on engineer-to-order (ETO) companies; we consider companies that sell complex and highly engineered products, such as cement or chemical factories, oilrigs etc.

Complexity in a manufacturing environment can be identified in products, processes and organization (Wilson and Perumal, 2009), and it lies upon each of those aspects but also in their interrelationships (Blecker et al., 2006)(Samy and ElMaraghy, 2012). There are several factors identified in the literature related to complexity of products' life cycle (ElMaraghy et al., 2012).

Additionally, the various benefits from the implementation of a PCS are discussed in the literature. PCSs have been implemented widely to support the specification

process for the customized products and guide the sales process (Zhang, 2014). The benefits from applying PCSs can be described in terms of shorter-lead time and improved quality of the product's specifications, reduced resource consumption and increased customer satisfaction (Tiihonen et al., 1996). The ability to make the right decisions in early stages of the sales and engineering processes is increased as sales persons and the customers are guided through the process by the PCS (Gronalt et al., 2007)(Slater, 1990). For that reason, less rework and less iterations are required, as the quality and the accuracy of quotations are increased (Hvam et al., 2004). Furthermore, PCSs can be used as tools that support sales persons to offer customized products within the boundaries of standard product architectures and thereby enable companies to be more in control of their product assortment (Forza and Salvador, 2002)(Fleischanderl et al., 1998).

As a result this research combines the fields of PCS and complexity, by identifying factors that indicate how product's life cycle complexity can be reduced by the utilization of a PCS.

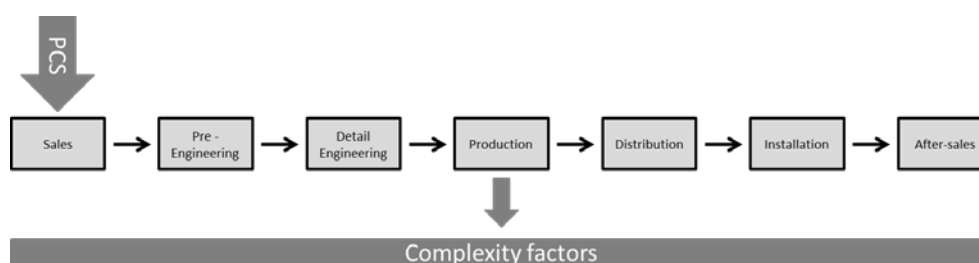


Figure 1 - Impact from implementing PCSs in the sales process on the different phases of the product's life cycle

Methodology

This paper examines the existing literature on the utilization of PCSs in ETO companies and quantifies the impact that a PCS has on the different phases of a product's life cycle. The aim of this study is to identify complexity factors in the different phases of a product's life cycle that are affected by the utilization of a PCS. The research is supplemented with empirical evidence based on a case study of a representative ETO company within the oil and gas industry. The unit of analysis is the different projects for a four-year period of time, which include both complete projects of oilrigs and sales of single equipment. The study follows a research protocol to ensure internal and external validity of the approach (Yin, 1994).

Findings

In the four-year time period, the company sold 12 projects and 193 single products. Based on the data acquired, the revenue for the projects is 743,5 m€ and for the single products 46,5 m€. Respectively, the costs are 758,7 m€ for the projects and 30,9 m€ for the single products. It can be seen from the numbers above that even though the projects create higher revenue compared to the sales of single equipment, the related costs are even higher, resulting in loss for the company. Furthermore, for the projects sold a deviation is identified between the estimated cost and revenue at the beginning

of the project, when the budget is calculated, and the actual ones, when the project is finished.

An area of interest identified during the analysis of the financial performance of the projects is the reduction of cost through repetition. When a project is re-produced based on an existing one, several cost categories are identified to have noteworthy reductions. This trend of cost reduction through reusability is identified in several costs which are related to different life cycle processes, such as production, engineering hours, the revisions of drawings and changes on the drawings, outsourced production equipment and commissioning.

Based on the analysis of the financial performance of the company two main areas of potential improvement can be identified as discussed in the literature (Jiao et al., 2007) (Blecker and Abdelkafi, 2006); standardization and reusability. In order to achieve these improvements, firstly, the company should increase the standardization of the product portfolio. By changing or adjusting the products' architecture, the company can seize the benefits of complexity reduction in the product assortment. Then, the standardization of the processes and the increase in material reusability can be achieved by implementing a PCS. Through the utilization of a PCS both product and process complexity can be reduced and this would have a direct effect of cost savings.

Conclusion

The scope of this study is to identify how the implementation of PCSs affects the complexity, in terms of cost reduction, through the different phases of a product's life cycle. By following the suggested method, areas that are improved by the implementation of a PCS are identified and the related cost improvements are quantified. Some examples of cost reductions are those related to production, engineering, documentation and specification processes. Regarding the case study, the potential savings vary from 4% to 15% throughout the entire products' life cycle as a result of the complexity reduction related to the implementation of the PCS.

Contribution

This research aims to provide an in-depth overview of the main complexity factors that can be addressed by the implementation of the PCS through the products' life cycle. By bridging the gap between the theories of PCS and complexity management, this study aims to assist in optimizing the potential benefits in terms of complexity reduction by the implementation of a PCS in the early phase of the sales process in manufacturing companies.

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